JUNOS SPACE CONNECTIVITY SERVICES DIRECTOR

Product Overview

Service providers and enterprises must be able to rapidly provision and offer new MPLS and carrier Ethernet services across their networks. In order to reduce operational costs and enable quick service rollouts, these network operators need an intelligent provisioning application that facilitates the design, deployment, and management of services.

Junos Space Connectivity Services Director facilitates life-cycle service management, addressing MPLS use cases such as:

- *Transport*
- *VPN services*
- *QoS*
- *Timing/synchronization*
- *OAM*

Featuring an intuitive GUI, Connectivity Services Director supports a rich set of APIs to enable northbound integration and service orchestration with other OSS platforms.

Junos Space Product Description

Juniper Networks® Junos Space® Connectivity Services Director is part of Junos Space, a comprehensive network management solution that simplifies management of Juniper's switching, routing, and security devices. Junos Space is a critical component of Juniper's SDN strategy. It provides a centralized management plane with a single point-of-access into the network, and a common management platform for managing and creating applications to meet your specific needs. With Junos Space, you can simplify and automate the network, improve network agility, and deliver new services quickly, all from a single console. Junos Space is composed of the following software elements:

- **Junos Space Network Management Platform:** Offers comprehensive fault, configuration, accounting, performance, and security (FCAPS) and element management of Juniper devices, improving operator efficiencies and providing a programmable interface and exposable APIs that enable the development and integration of third-party applications

- **Junos Space Management Applications:** Provides plug-and-play, domain-specific applications to help you provision new services and optimize workflow tasks across thousands of Juniper devices

The Junos Space Network Management Platform infrastructure includes the basic capabilities for device management and system administration, such as:

- Device discovery
- Device image management
- Device inventory management
- Script management
- Log files management
- User and security administration
- Fault management
- Performance management

In addition to these basic functions, the Junos Space Network Management Platform facilitates a multitenant, plug-and-play application environment that enables fast startup and in-service device upgrades.

While the Junos Space Network Management Platform offers broad fault, configuration, and device provisioning capabilities with a task-specific user interface, Junos Space Management Applications extend the breadth of the platform to optimize network management for various domains. The Connectivity Services Director application runs on the Junos Space platform, where it enables users to automate the end-to-end provisioning of new services across thousands of devices with a simple point-and-click GUI, and to optimize management for specific domains such as core, edge, access and aggregation, data center, WAN, and campus and branch.

Resource Management	Service Design	Service Provisioning	Validation and Troubleshooting
Device and services inventory	Pre-defined and custom templates for services	Rapid provisioning of services	Network performance and SLA assurance

Figure 1: Junos Space Connectivity Services Director Functions

Connectivity Services Director Product Description

Companies that offer MPLS and carrier Ethernet services face common business challenges such as controlling capital and operating expenses, accelerating time to market, and increasing customer satisfaction. At the same time, these companies also have to deal with technical challenges such as:

- Provisioning a customer service rapidly and accurately
- Scaling to keep up with customer demand
- Tracking site-specific quality of service (QoS)
- Troubleshooting and pinpointing problems in the network

Junos Space Connectivity Services Director allows service providers and enterprises to rapidly enable new service offerings. It facilitates an automated and streamlined approach to the service design and provisioning process, reducing fallout from misconfigured customer services and increasing customer satisfaction and retention. Besides automating key provisioning tasks, Junos Space Connectivity Services Director also provides a complete network management solution, including automated service discovery, MPLS resource management, point-and-click service provisioning, validation, as well as monitoring and troubleshooting for legacy ATM/TDM, MPLS, and carrier Ethernet environments.

Junos Space Connectivity Services Director manages the life cycle of services comprised of resource pool management, service design, service provisioning, service troubleshooting, service monitoring, service-level agreement (SLA) monitoring, and service decommissioning. High-level capabilities include:

- Automating the design, activation, and validation of the provisioning process for E-Line, E-LAN, IP services across ATM/TDM, MPLS, and carrier Ethernet networks, enabling service providers to efficiently and cost-effectively manage deployments while reducing fallout from misconfigured services
- Designing, provisioning, and activating RSVP-signaled label-switched paths (LSPs), as well as static LSPs, which can be configured as end-to-end, point to point (P2P), point to multipoint (P2MP), or full mesh
- Monitoring service faults and performance of VPN services using standards-based protocols and technologies such as

Ethernet connectivity fault management (CFM), Ethernet link fault management (LFM), and Bidirectional Forwarding Detection (BFD)

- Enforcing SLA of VPN services using Y.1731
- Provisioning synchronization interfaces such as IEEE1588-2008(PTP) and Synchronous Ethernet

The Junos Space Network Management Platform and Junos Space Connectivity Services Director are both accessible through a northbound Representational State Transfer (REST)-based API. This enables network providers to tap into the rich functionality of Junos Space and build native applications on their operations/business support systems (OSS/BSS) as they begin to embrace SDN architectures in their networks.

Connectivity Services Director manages the services shown in Table 1.

Table 1: Services Managed by Connectivity Services Director

Use Case	Service Supported	Service Type
Transport	RSVP LSP	• Point to point (P2P) • Point to multipoint (P2MP) • Full mesh
	Static LSP	• Single hop • Multihop • Bypass
	Generic routing encapsulation (GRE) tunnel	• Full mesh • Hub and spoke
VPN	E-Line (multi-segment)	• Layer 2 circuit (E-Line Martini) • L2VPN (E-Line Kompella) • EVPN-VPWS
	E-LAN	• VPLS • EVPN(E-Tree) • Virtual switch
	IP	• VRF • Virtual router • IP transit
OAM	CFM	• E-Line • E-LAN • Interface
	LFM	• Interface
	Y-1731	• E-Line • E-LAN
	RFC-2544	• E-Line • IP • Interface

Use Case	Service Supported	Service Type
Timing	Precision Time Protocol (PTP)	• Ordinary Clock • Boundary Clock
	Synchronous Ethernet	• Network Option-1 • Network Option-2
Juniper Networks NorthStar Controller integration	RSVP LSP (PCEP, NETCONF-based)	• P2P • P2MP • Full mesh
	Segment routing (PCEP-based)	• P2P • P2MP • Full mesh

Device Pre-Staging

As part of device pre-staging, Connectivity Services Director automatically identifies the devices which are capable of MPLS services. This involves assigning network provider edge (N_PE) and provider (P) roles to devices. It also identifies corresponding user-to-network interfaces (UNIs) and network-to-network interfaces (NNIs) on the devices. Assigning device and UNI roles helps simplify service provisioning by allowing only qualified devices and interfaces to be selected for services.

Device Monitoring

Device monitoring for device status, interface status, and interface utilization is an important requirement for any service provider. Connectivity Services Director offers additional features on top of those provided by the Junos Space Network Management platform. One such feature, Chassis View, provides a three-dimensional view of the actual chassis, showing the real-time status of the device, installed PICs, and interface status.
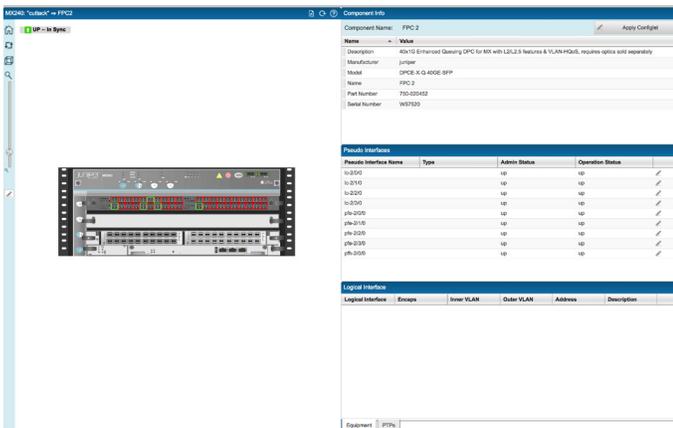

Figure 2: Chassis View for a Juniper Networks MX240 3D Universal Edge Router

As part of the device monitoring process, the Connectivity Services Director collects all traffic statistics including unicast packets, multicast packets, error counters, and utilization data of all interfaces on the device.

Figure 3: Device monitoring traffic summary

Automated MPLS Resource Management

Deploying carrier Ethernet services requires multiple network resources to be allocated and tracked. These resources can be network-wide, device-specific, or per customer-specific. The most common resources are:

- Network Resources: Route target, route distinguisher, Ethernet segment identifier (ESI), L2 VPN IDs, virtual private LAN service (VPLS) ID, virtual circuit (VC) ID
- Device Resources: Unit, VLAN (Dot1q, QinQ)
- Customer Resources: IP pools

When a service provider is handling hundreds of customers, each being provisioned for hundreds of services, tracking network resources can quickly become unmanageable and unscalable—particularly when the resources are tracked manually. For example, if a customer is experiencing packet loss from one site to another, how quickly can a help desk operator troubleshoot the problem?

Connectivity Services Director provides automated MPLS resource management as well as an auto allocating feature:

- Unit, VLAN IDs (Dot1q, QinQ), ESI to the UNIs
- VC IDs, VPLS ID, route target, route distinguisher, L2VPN IDs
- IPV4 addresses to provider edge-customer edge (PE-CE) interfaces

This not only minimizes user input during provisioning but also guarantees that the service provisioning pushed to the devices does not conflict with existing resources on the network.

Service Design

Service Design allows service providers to customize services by allowing dynamic association of attributes to the service based on customer needs. A single design can be used to provision hundreds of services. The service design also allows the service

designer to decide how the resources for the service should be selected, whether the Connectivity Services directory uses an automated service to pick resources, or whether an operator should manually enter the values.

Connectivity Services Director comes with predefined service definitions that capture Juniper best practices for standard services in terms of the options selected, prefilled values for attributes such as bandwidth, maximum transmission unit (MTU), interface encapsulation, and more. Service providers can create custom service definitions based on the service requirements.

Service Provisioning

Seventy-five percent of network outages are due to human error, such as misconfigurations when changing an existing customer. Imagine that you have to activate a 20-site VPLS for a customer. Do you start a spreadsheet and keep track of the endpoints, PE routers, interfaces, VLANs per interfaces, route targets, route distinguishers, and other MPLS resources? To use this approach, you would start by configuring the first site with great attention to detail, update your spreadsheet or piece of paper, and slowly make your way to the twentieth site by the end of the week. Now, how do you know that the VPLS for the twentieth site is working? You need to go site by site and verify that you have reachability to all remote sites, issuing 20x19 pings.

What happens when you lose the spreadsheet that contains all of the information for this customer VPN? What do you do if you need to add a twenty-first site to this VPN and verify that this new site is working with the 20 preceding sites?

Connectivity Services Director provides a simple GUI-based provisioning tool that allows the operator to easily select the endpoints for activating multisite services. It also provides pre-validation before applying configuration to target devices, verifying that there are no collisions with existing configurations on the target devices and ensuring that a set of network parameters ultimately works and renders the service functional.

Service Validation and Troubleshooting

Generating an accurate configuration and applying that configuration is the first step in managing a service. However, ensuring that the service is operational requires an additional step that Connectivity Services Director provides. Verifying that the control plane and data plane are functional guarantees that the service is actually up and running.

The real value of Junos Space Connectivity Services Director comes when the number of sites is large. The Functional Audit feature verifies the service status both toward the core and access side. On the core side, it does a control plane and data plane validation across all sites in the service. On the access side, it checks the interface status of all endpoints.

If one or more sites are not reachable, the operator is immediately alerted to the broken sites with a detailed analysis of the failure conditions. Predefined Stylesheet Language Alternative Syntax (SLAX) scripts are available to help in troubleshooting. Customized SLAX scripts can be associated with services for additional troubleshooting.
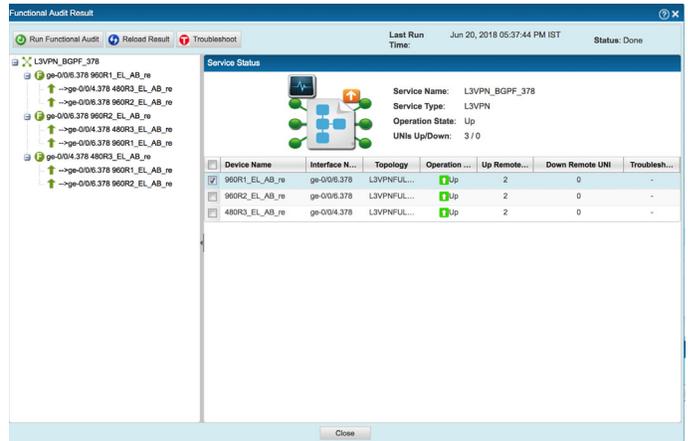

Figure 4: Functional Audit—control plane and data plane validation

The ability to monitor status, traffic utilization, and SLA services is important for any service provider. Connectivity Services Director monitors all managed services, including:

- Service Summary: Provides overall status of the service along with control plane status for each pair of devices
- Service Traffic: Provides interface traffic for all endpoints that are part of the VPN service
- Service Transport: Provides the LSP associated between provider edge devices being used by the VPN service
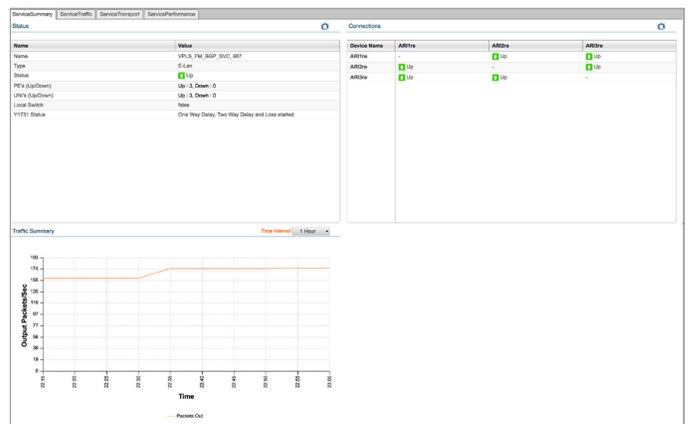- Service Performance: Provides Y.1731 performance data for E-Line and E-LAN services

Figure 5: Service monitoring

OAM and SLA Monitoring

After a service has been provisioned, the service provider must be able to monitor the service in order to guarantee SLAs. Monitoring involves checking end-to-end path connectivity of the control plane and data plane. Control plane validation involves verifying that the MPLS edge routers have indeed established logical connections. Data plane validation involves MPLS ping/trace route to ensure that the data plane is indeed working. Connectivity Services Director provides the following Operation, Administration, and Maintenance (OAM) and SLA monitoring capabilities:

- Connectivity fault management (CFM) at the interface level
- Service-level CFM for E-Line and E-LAN services
- Link fault management (LFM)
- MPLS ping for LSP and VPN services
- MPLS traceroute for LSP services
- Support for Y.1731-based one-way and two-way measurements for frame delay, frame delay variation, frame loss, and service availability

Connectivity Services Director enables users to set up CFM flows between service endpoints in order to monitor the end-to-end service using Y.1731 frames. Users can choose to gather performance data on demand, or create SLA iterators and assign them to a service in order to periodically measure the data. In addition to these iterators, users can also associate an action profile with a service to describe actions that must be performed when connectivity problems are detected with the service.
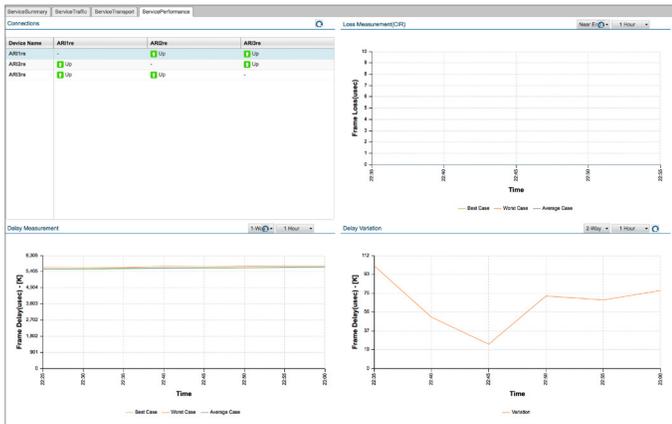

Figure 6: Performance data collected through OAM flows

Service Fault

Faults are very important events, immediately notifying the service provider of an impending problem in the network. Devices send alarms on events impacting them, and these alarms, in turn, might be impacting the customer service. The device may not be aware of direct impact of an alarm on the network or the service, but Connectivity Services Director correlates the two. As soon as Junos Space receives a device alarm, the Correlation Service checks if any service(s) are impacted because of this device alarm. Based on impacted service(s), a service alarm is raised on each service, alerting the operator about any potential impacts. As soon as a device alarm is cleared, service alarms are cleared for affected services.

Service Recovery

Consider a scenario where a service provider has installed Connectivity Services Director as a brown field installation. The service provider might have hundreds of services deployed in the network and no longer wants to manually manage them. For service providers who would like to bring all of these services into Connectivity Services Director, Connectivity Services Director has a Service Recovery feature to upload these services and manage them.

Topology

Viewing a network topology is an important aspect of any management solution. Connectivity Services Director has a BGP-LS based topology view that can be grouped based on:

- IS-IS area
- Autonomous number
- Custom group view

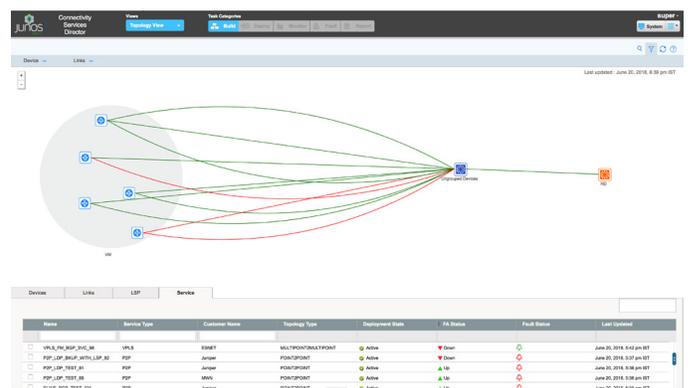The topology view also shows optical links in the network.

Figure 7: Network topology—custom group view

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Synchronization Management

Junos Space Connectivity Services Director includes an optional component that manages synchronization devices such as the Juniper Networks TCA Series Timing Appliances, as well as synchronization subsystems within other Juniper devices that support the IEEE 1588-2008 standard—commonly known as Precision Time Protocol (PTP) and Synchronous Ethernet. In addition to managing device-level synchronization attributes, Connectivity Services Director also manages logical timing entities or domains that comprise groups of devices or subsystems. Users can create timing domains, assign various synchronization devices and subsystems to a domain, and then apply a specific timing service template to each domain. Connectivity Services Director scans the devices in the timing domain and performs configuration operations one-by-one based on the service template, automating and simplifying the configuration process.

Features and Benefits

Feature	Feature Description	Benefits
Removal of all possible manual configuration errors	• Junos Space Connectivity Services Director provides a centralized location for all L2VPN and L3VPN services.	• Reduces meantime to recovery (MTTR) when troubleshooting customer connectivity issues.
Reliable and scalable architecture	• Junos Space Connectivity Services Director runs on a distributed and scalable architecture. • The Junos Space fabric can be expanded organically, as administrators can simply add nodes to increase scalability. • Users can monitor the health of the fabric and adjust node membership, as needed. The application automatically load-balances the processing across any new nodes, as required.	• Allows for a resilient application infrastructure. • Allows for expansion of the application infrastructure with the growth of the number of devices, number of GUI operators and northbound operations support systems (OSS) clients. • Enables geographically distributed data centers to operate on the same Junos Space fabric. In case one data center is not operational, the secondary data center can still provide full management capability to continue operations.
Autodiscovery (AD) and inventory of network devices	• Using IP address range, IP subnet and hostname, Connectivity Services Director is able to connect to and bring in the complete physical inventory of the managed devices.	• Provides a complete and accurate device inventory of line cards, PICs, interfaces, Juniper Networks Junos operating system version, chassis type, and serial number that is accessible in one single place.
Automated MPLS and network resource management	• Leveraging Juniper best practices, there is a set of predefined network signature rules that help with identifying the MPLS role, UNI, and NNI. When configuring carrier Ethernet services, a large number of network resources typically need to be allocated and tracked for a given MPLS service.	• Provides automated resource allocation and management for network and device resources. • Provisioning Ethernet services at scale becomes fast and efficient by automating network resource allocation.
Service design	• Leveraging Juniper MPLS best practices, Connectivity Services Director has predefined service offering designs for LSP and VPN services. Service designers can further customize a carrier's predefined service offering designs.	• Time to market is shortened, providing a turnkey service model that can be leveraged rapidly. • Custom service definitions allow for flexibility in service provisioning.
Point-and-click provisioning	• Simple point-and-click provisioning allows the operator to easily select the endpoints for activating a customer VPN. • MPLS services supported are carrier Ethernet E-Line and E-LAN (with E-Tree and multihoming) services. IP services along with LSP services are also supported.	• Removes all possible manual configuration errors. • Provides one centralized location to track all customer VPN services (E-Line, E-LAN, IP). • Reduces MTTR when troubleshooting customer connectivity issues.
Configuration pre-validation	• Before deploying carrier Ethernet services, pre-validation is done to determine if there are any conflicts with selected network parameters—VLAN IDs, VC ID, route targets (RTs) collision, uniqueness of route distinguisher (RD).	• All of these network pre-validations provide a certain level of assurance that the service intended by the operator has no conflicts and is configured correctly without errors.
Configuration post-validation	• Connectivity Services Director validates at a configuration level to determine if the intended configurations are present on all targeted devices.	• Ensures that the service configurations are present as intended by the operator.
Operational validation	• In order to ensure that carrier Ethernet services are operational, two validation levels are executed—control plane and data plane validations.	• Provides the operator with a clear assurance that carrier Ethernet services are indeed working.
Create, Read, Update, and Delete (CRUD) functionality	• CRUD operations are available for all services supported.	• Customers can easily create, read, update, and delete their services.
Synchronization management (option)	• Connectivity Services Director allows configuration of PTP and Synchronous Ethernet interfaces across Juniper devices.	• Provides network-wide consistency in the management of synchronization—a critical requirement for 3G/4G/LTE networks.

Feature	Feature Description	Benefits
Performance monitoring	• Connectivity Services Director facilitates fault monitoring of ports, interfaces, and services and provides network performance data.	• Provides an early warning about network problems and allows service providers to meet SLAs.
Topology view	• Connectivity Services Director has a BGP-LS based topology view. Optical links in the network are also available in topology view.	• Multiple overlays can be viewed as part of a topology view link layer, transport layer, and service layer.
NorthStar Controller integration	• Connectivity Services Director uses the NorthStar Controller REST API to manage LSP services and give a single pane of glass for VPN services and LSP services managed by NorthStar Controller.	• Customer can create LSP(s) as part of VPN service provisioning in a single REST API call. • Connectivity Services Director will take care of creating the LSP(s) and VPN service and making sure they are deployed on the network. • It will also associate the created LSP(s) with VPN service.
OSS/BSS integration (option)	• Connectivity Services Director provides REST API for northbound OSS/BSS to access the applications and orchestrate other services.	• Simple interface to achieve platform extensibility, multivendor support and service orchestration.

Table 2: Supported Platforms and Models for Connectivity Services Director

Supported Platforms	Supported Models	
ACX Series Universal Access Routers	• ACX500 • ACX1000 • ACX1100 • ACX2000 • ACX2100 • ACX2200	• ACX4000 • ACX5048 • ACX5096 • ACX5448 • ACX5448-D • ACX5448-M
MX Series 3D Universal Edge Routers	• MX80 • MX104 • MX240 • MX480 • MX960	• MX2010 • MX2020 • MX10003 • MX10008 • MX10016
M Series Multiservice Edge Routers	• M320 router • M7i • M10i	
PTX Series Packet Transport Routers	• PTX3000 • PTX5000	
EX Series Ethernet Switches	• EX4550 • EX4600 • EX9200	
QFX Series Switches	• QFX5100 • QFX5110	

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About Juniper Networks

Juniper Networks brings simplicity to networking with products, solutions and services that connect the world. Through engineering innovation, we remove the constraints and complexities of networking in the cloud era to solve the toughest challenges our customers and partners face daily. At Juniper Networks, we believe that the network is a resource for sharing knowledge and human advancement that changes the world. We are committed to imagining groundbreaking ways to deliver automated, scalable and secure networks to move at the speed of business.

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